TopoClusters for UE studies using 900 GeV data

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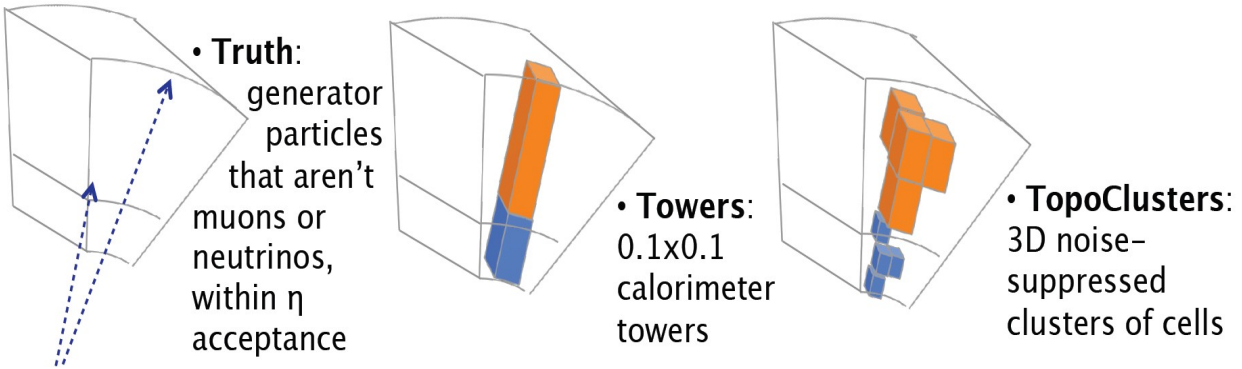
UE meeting, Status report

Goals

- **Use TopoClusters for the UE studies**
  - Systematically completely independent of tracking
  - Look at a complete final state (charged & neutral particles)
  - More relevant for future jet-based studies
- **Understand relationship between a particle and a TopoCluster**
- **Understand energy scale, resolution, unfolding procedure & systematic**
- **As a side study, to check what exactly goes into the jet constituents**

Picture from P.Loch's talk



Expected features:

- threshold effect (for TopoClusters with energy ~1 GeV, <E/p> ~ 0.3)
- energy scale uncertainties
- magnetic field distorts the initial direction of charged particles entering the calorimeter
- large resolution (picking highest-pT cluster does not always means going to a large energy scale)
- particles with large pT inside jets can be represented by fewer clusters (overlap effects)
  - can lead to a significant unfolding correction at large pT

Event selection and observables

- Good runs Solenoid=ON, Toroid=ON
  - 141565, 141707,141746,141748,141811,142166,142191,142193,142195,142383
- Monte Carlo sample: ATLAS-GEO-08-00-02 (r1051)
- L1_MBTS_1 trigger
- At least 3 tracks for the primary vertex
- Calibrated TopoClusters

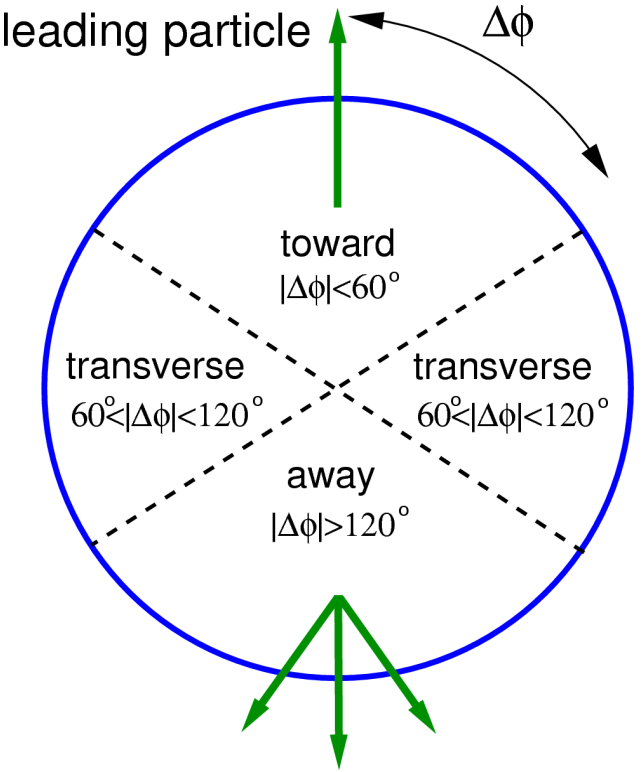
Analysis is done using ESD's (ESD->Ntuples->Histograms) at ANL Tier3

UE measurements:

Repeat the tracking measurements presented in ATL-COM-PHYS-2010-164 and ATL-COM-PHYS-2010-164

- Select on the highest pT particle (cluster)
- Use it as an energy scale
- Calculate difference in azimuthal angle between particle and any other particle in event

- Repeat the same for different pT's of the leading cluster
- Look at different regions (toward, transverse, away) and
  - <pT> as a function of pT(lead)
  - <pT> as function of N(clusters)
  - Same for densities and energy flows



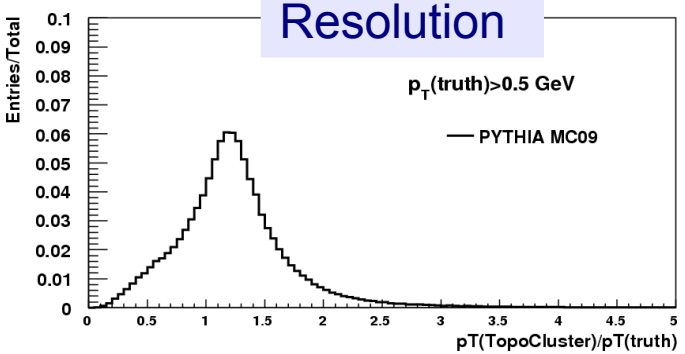
Plan of this talk

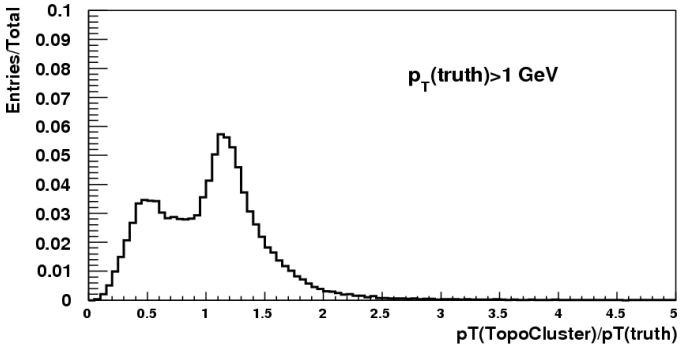
- Discuss TopoClusters after calibration.
- Reconstruct detector-level distributions, correction factors, unfolded distributions
- What measurements can be considered?
  - Must be **sensitive to the physics we are interested in** (i.e.UE)
  - Must be **instrumentally well measured**
    - Small bin-by-bin correction factors: C= N(gen)/N(reco) = purity / efficiency
    - Means small instrumental systematics
      - Small sensitivity to miscalibration, cut threshold effects, energy scale etc.
- Look at the EM-scale. Can the EM-scale TopoClusters change the conclusion
- Use the central region |eta|<2.5
  - easier to control the scale, possible cross check with tracks
  - under pressure of moving towards 7 TeV data..

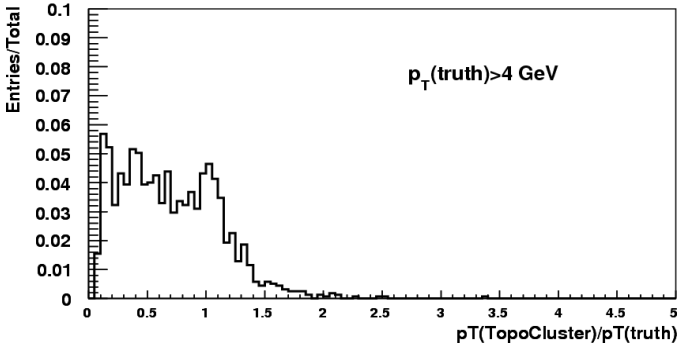
TopoClusters at calibrated scale

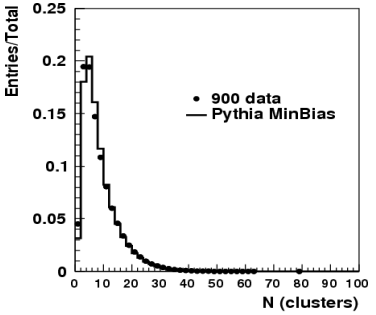
Look at **Calibrated TopoClusters**. Use MC09 MinBias PYTHIA vs 900 GeV data

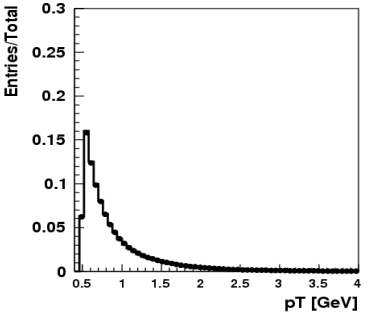
Resolution

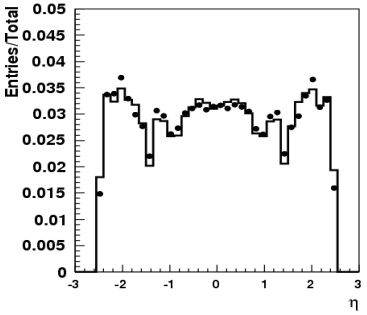


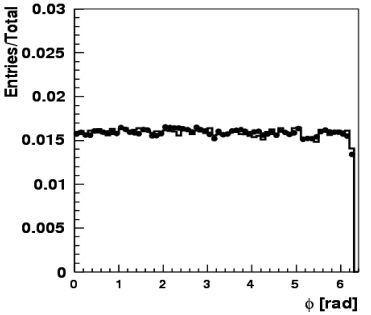


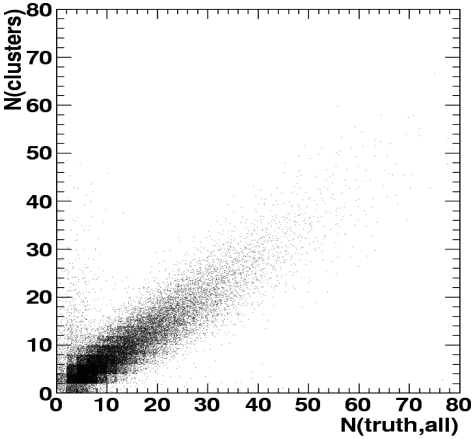












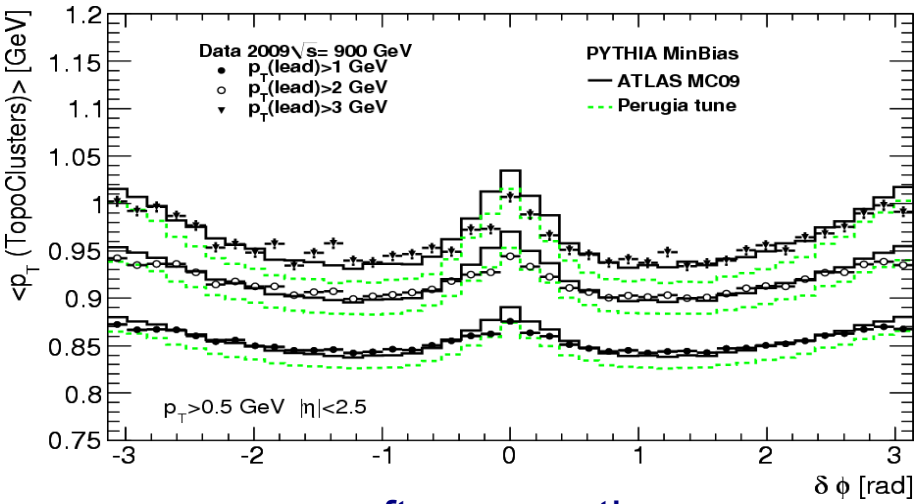
For the considered pT, topoclusters are miscalibrated (shift by 20%)

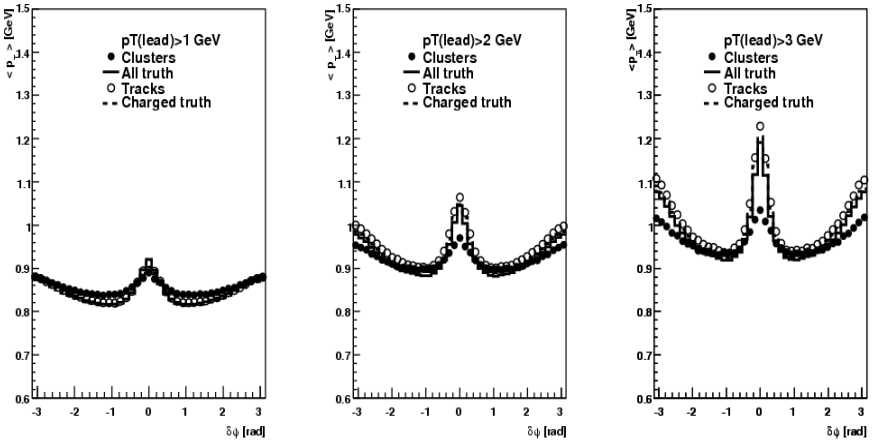
But good correlation between <N(clusters)> and <N(truth)

Good agreement between data and MC for all kinematic variables
Small different between data and MC for small-N (diffraction!)

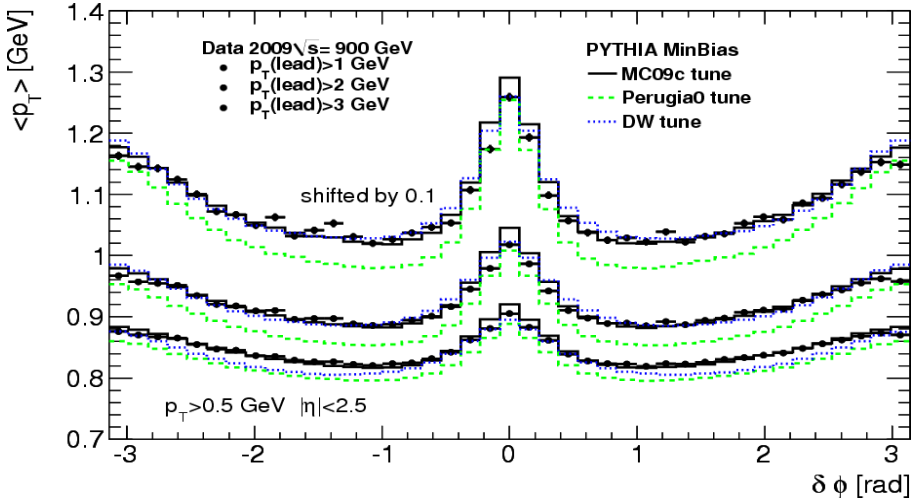
δφ measurements: average pT

detector-level

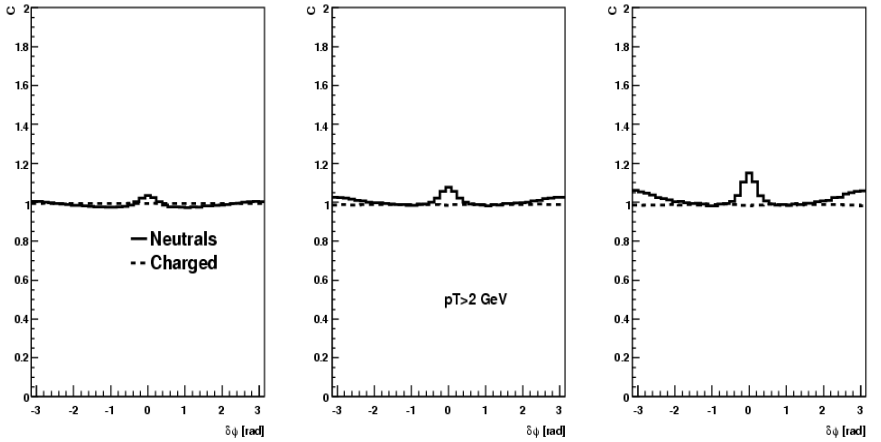




after correction



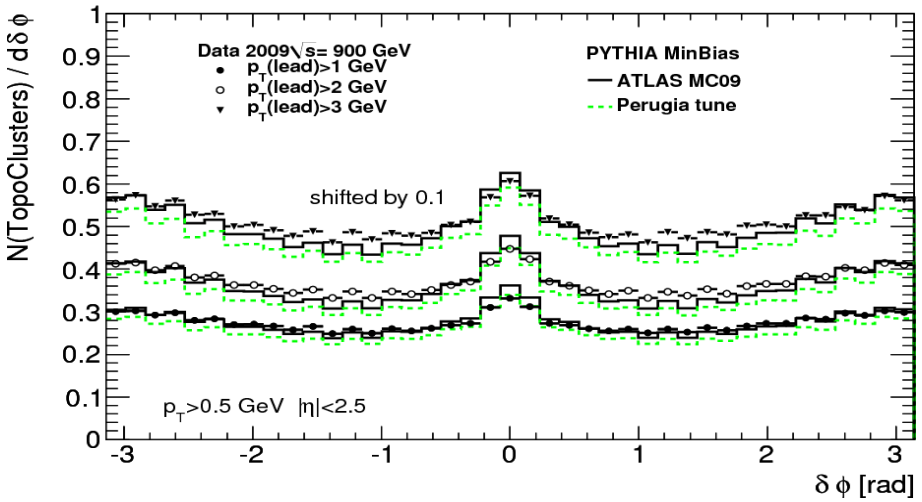
bin-by-bin corrections

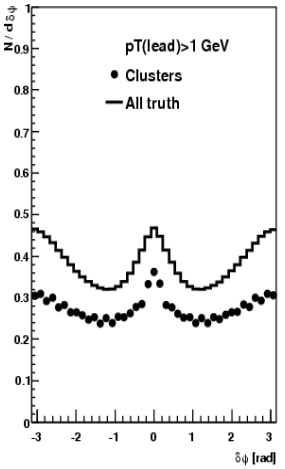


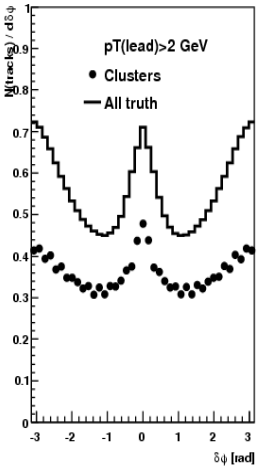
- "birth" of the leading jet (at δφ=0) and second leading jet (δφ=-π,π)with increase of pT
- Shows "average size" of leading (δφ=0) and second leading jet
- Perujia0 tune is significantly below the data
- Unlike previous measurement, **correction factors are small.**

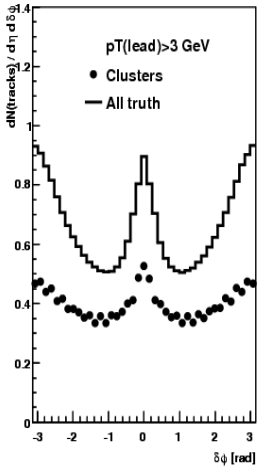
δφ measurements: particle densities

detector-level

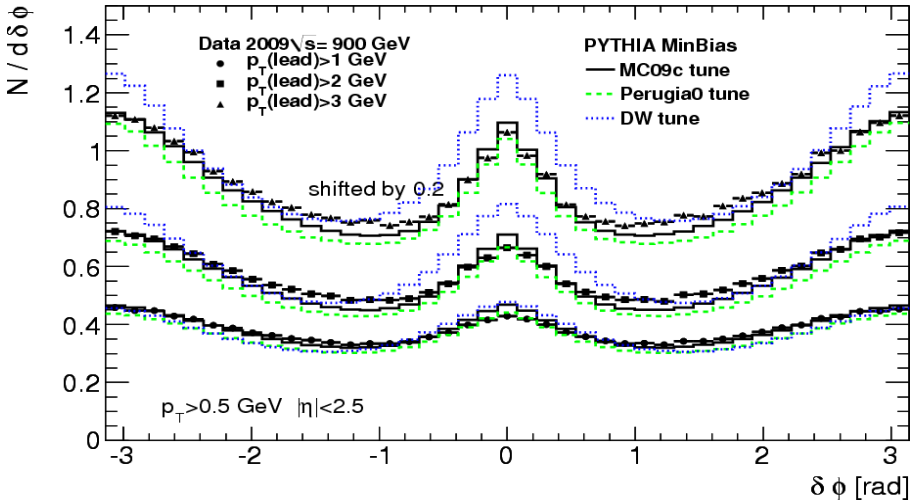




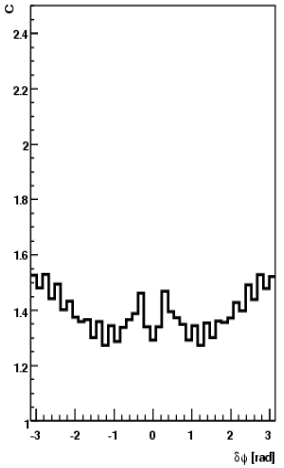


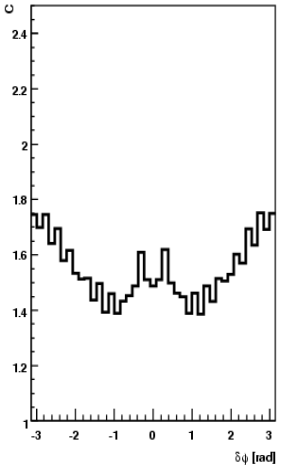


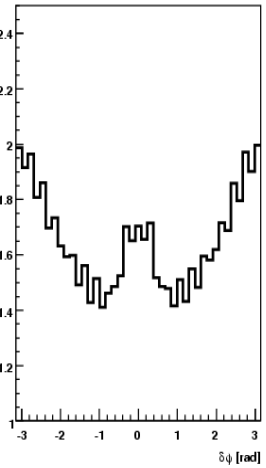
after correction



bin-by-bin corrections



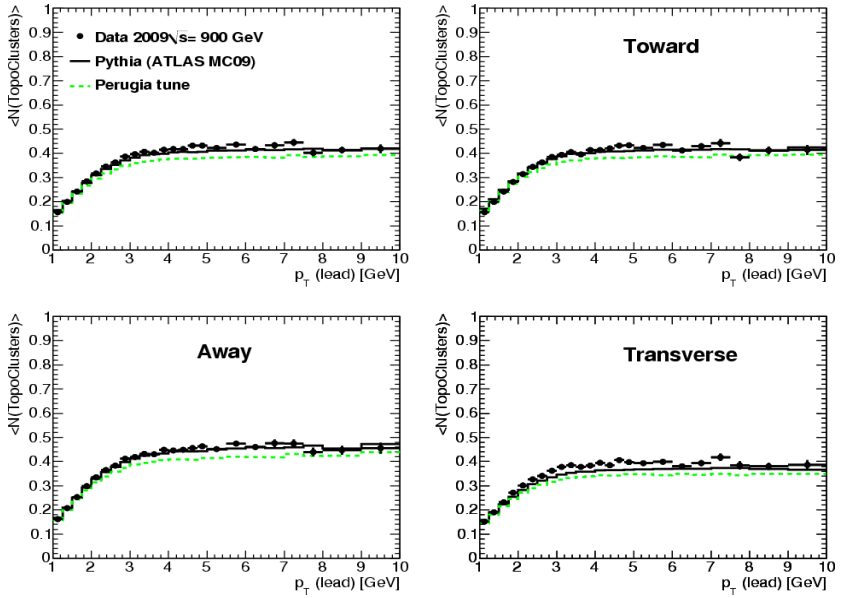




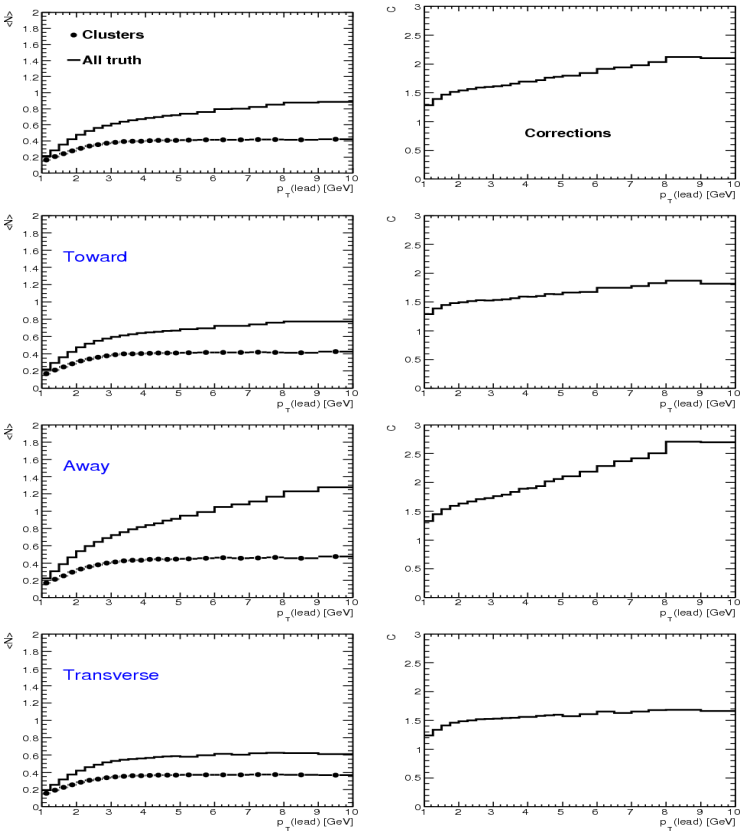
- "birth" of the leading jet (at δφ=0) and second leading jet (δφ=-π,π)with increase of pT
- Shows "average size" of leading (δφ=0) and second leading jet
- Differences with Pythia MinBias in shapes and normalization
- Correction factors are not small, but the same difference between data and MC is already present at the detector levels. Similar conclusion is obtained for average-pT flow (also similar correction factor)

Densities as a function of pT(lead)

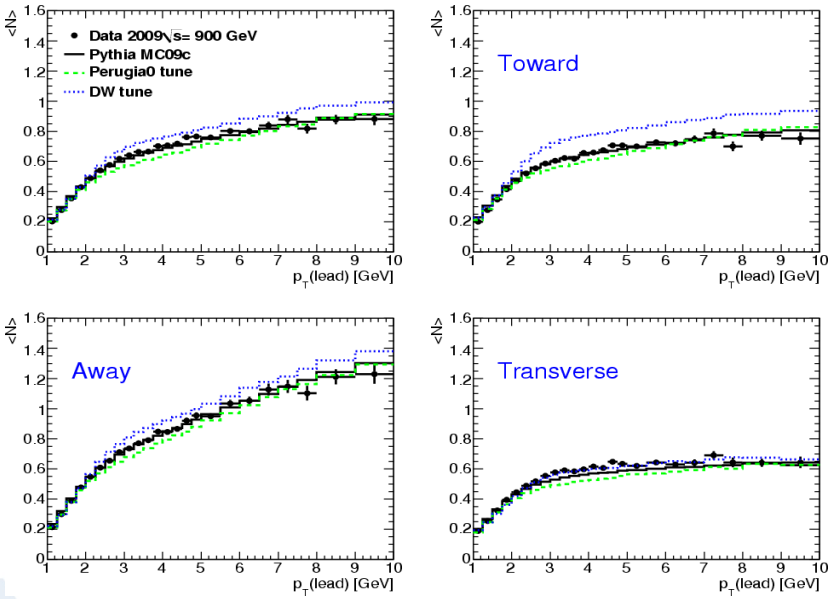
detector-level



bin-by-bin corrections



after correction



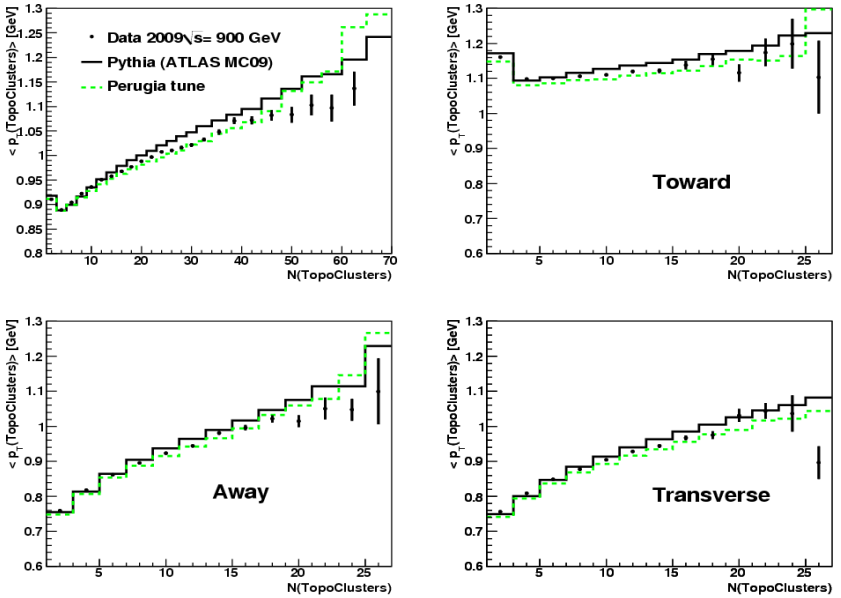
- corrections are rather large at large pT(lead)

- rise as a function of pT(lead) is driven by corrections (picking lead TopoCluster does not mean going to harder scale due to the resolution effects)

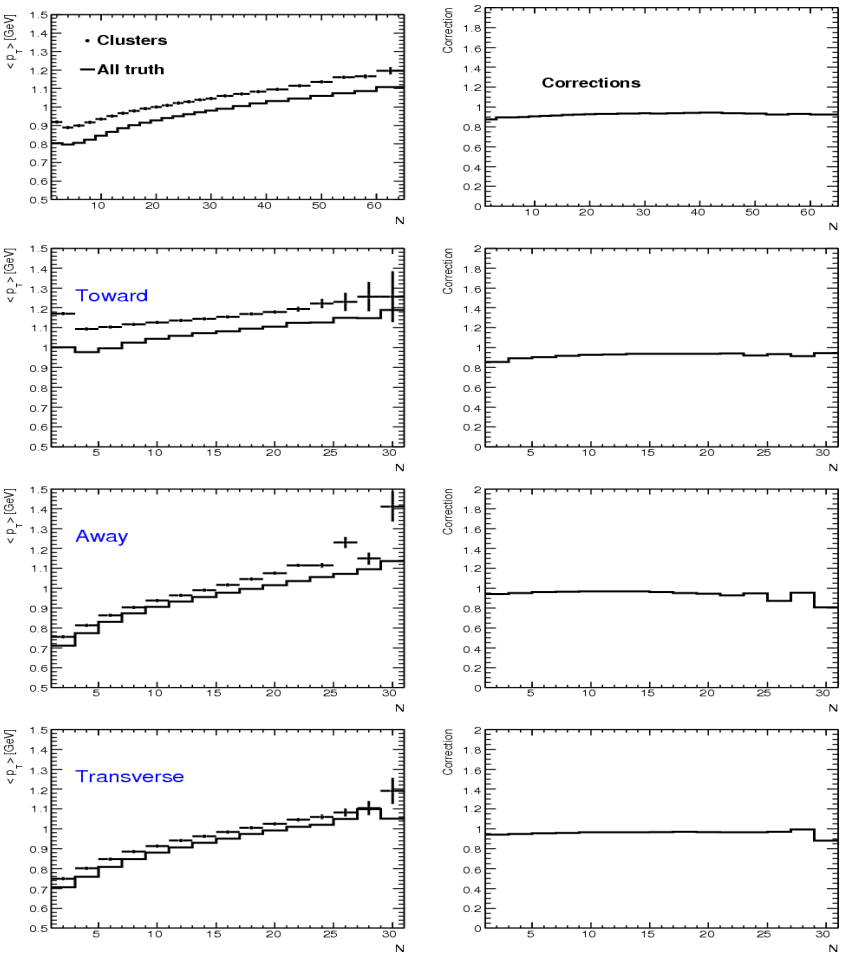
- but difference between data and MC remains the same after correction. We do not lose this information by applying the bin-by-bin corrections!

Average pT as a function of multiplicities

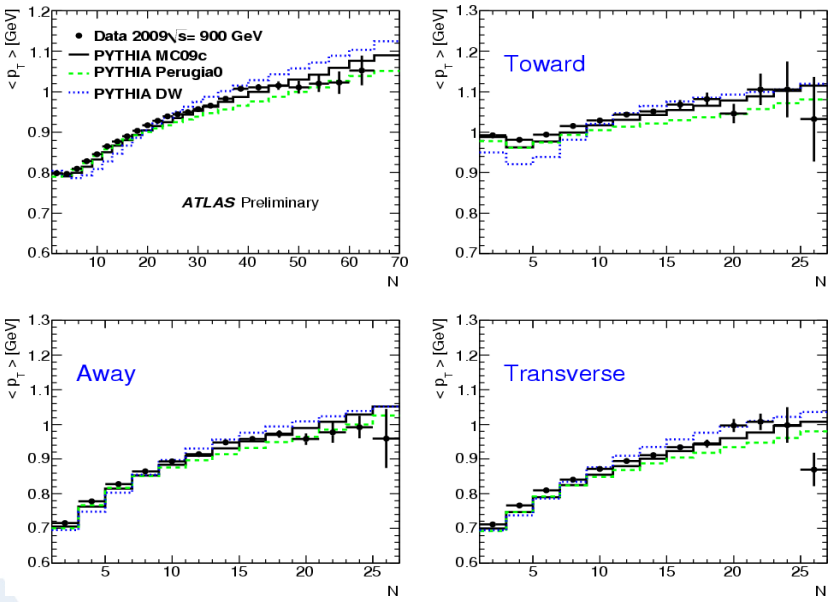
detector-level



bin-by-bin corrections



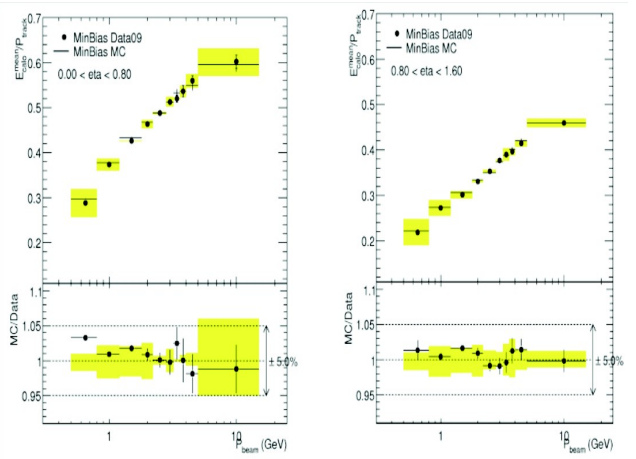
after correction



Corrections are small (~1)

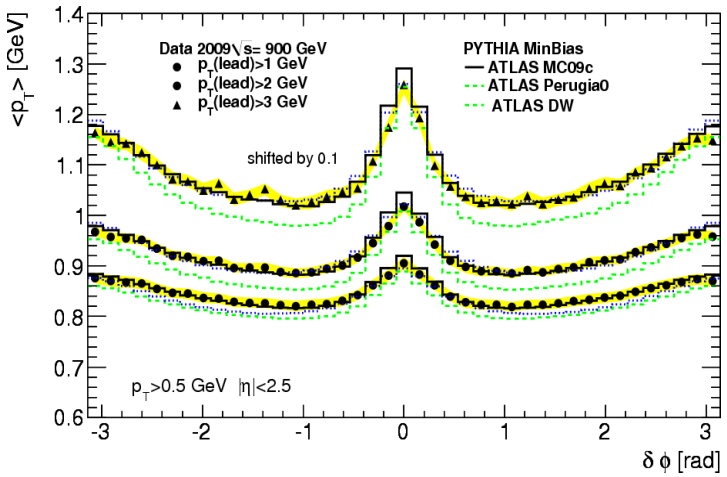
Inefficiency affects both X and Y axes.

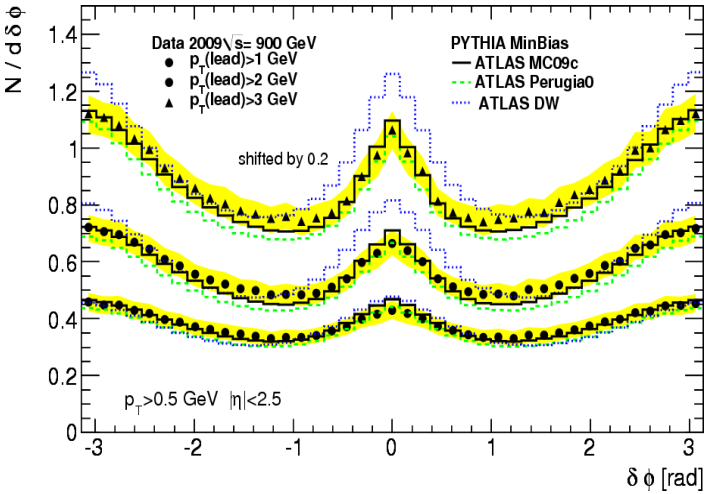
Systematic uncertainties

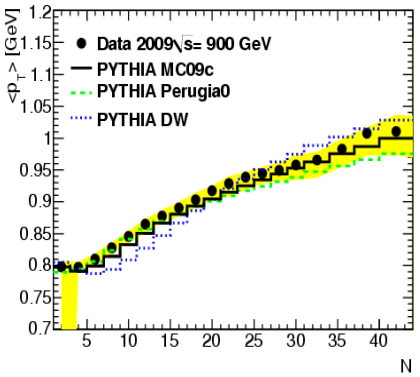


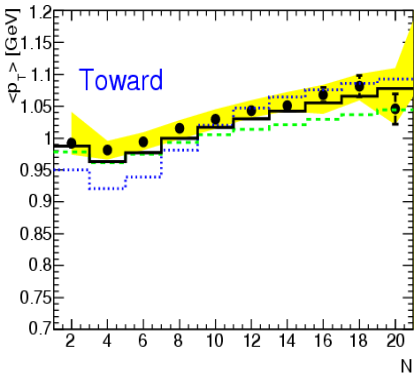
- Reject events with N(clusters)<3 (diffraction)
- ±5% energy scale
- 10 MeV electronic nose shift in MC
- ± 0.025 rad for cluster centers φ and η (one-cell shift)
- +10% extra material.
- Using Peruji0 for unfolding
- Repeat the analysis using EM-scale clusters
- Working on the pi0 peak to understand systematics

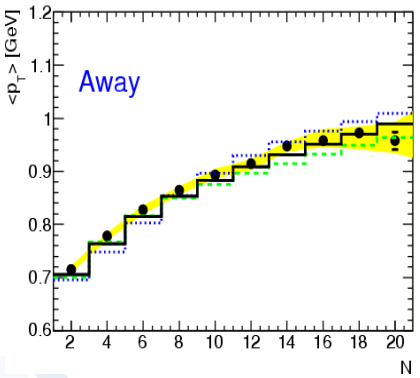
Figures with systematics included

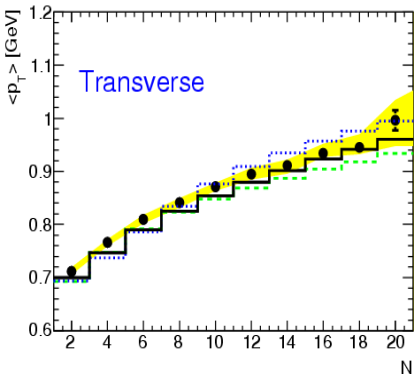


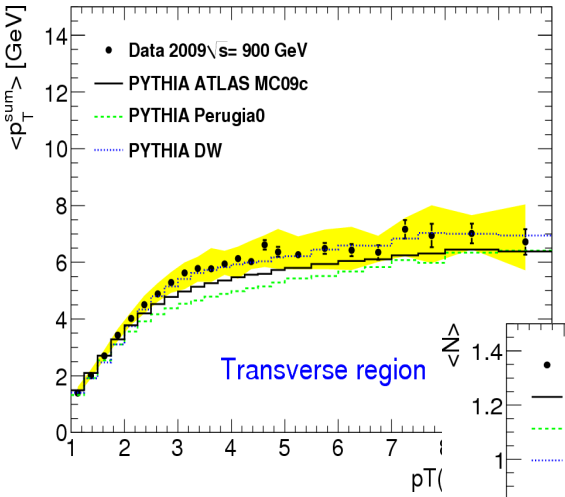


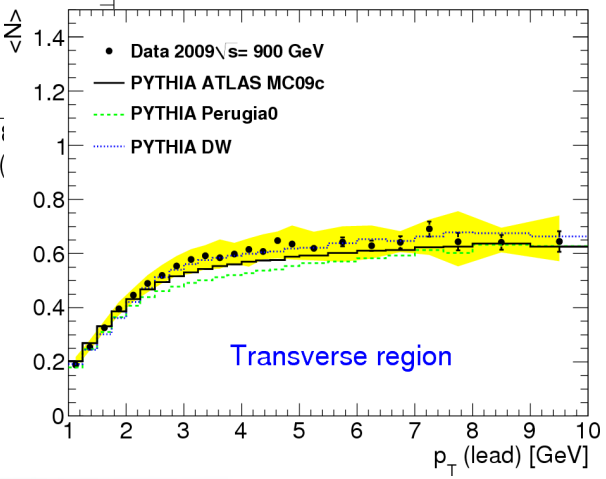




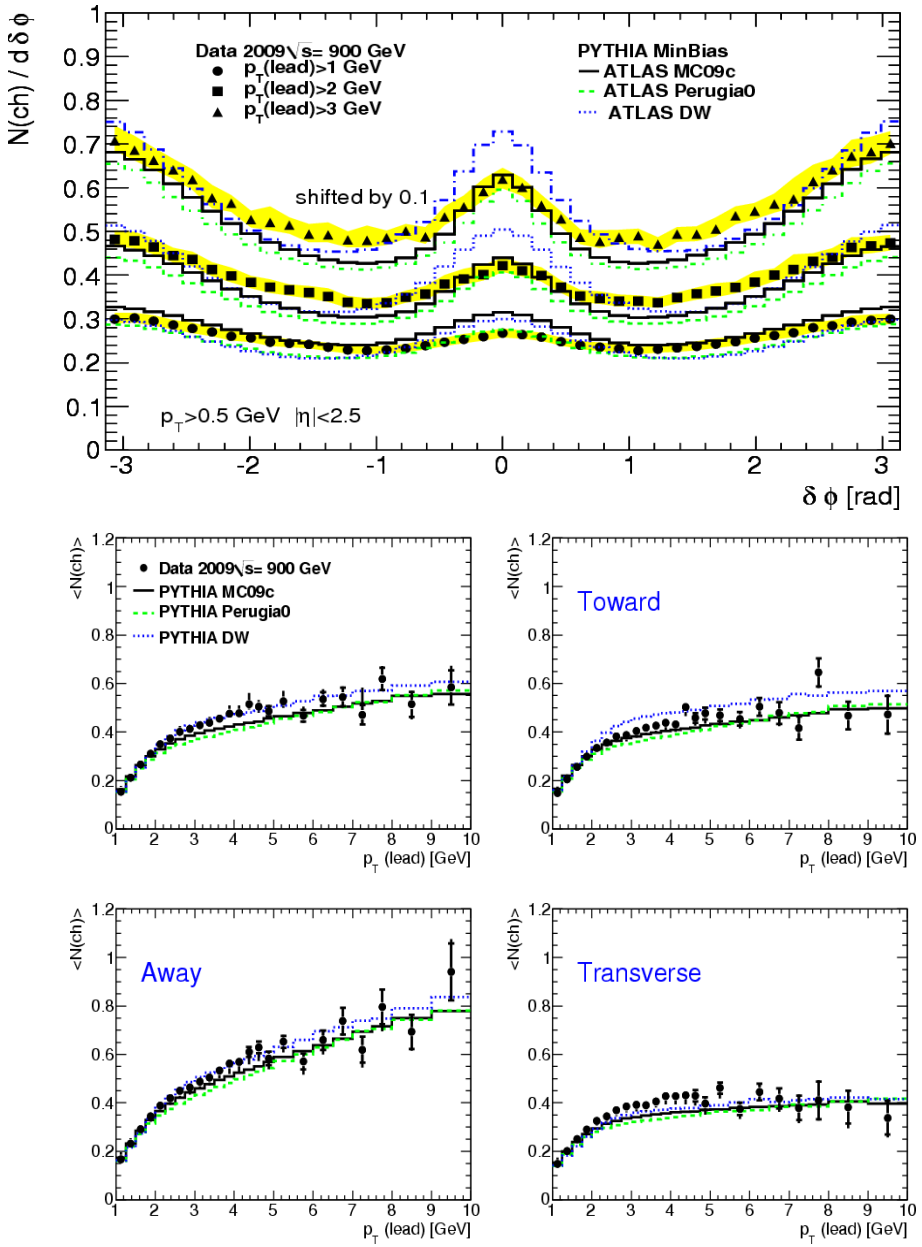








Results are similar as in the UE/MinBias tracking notes



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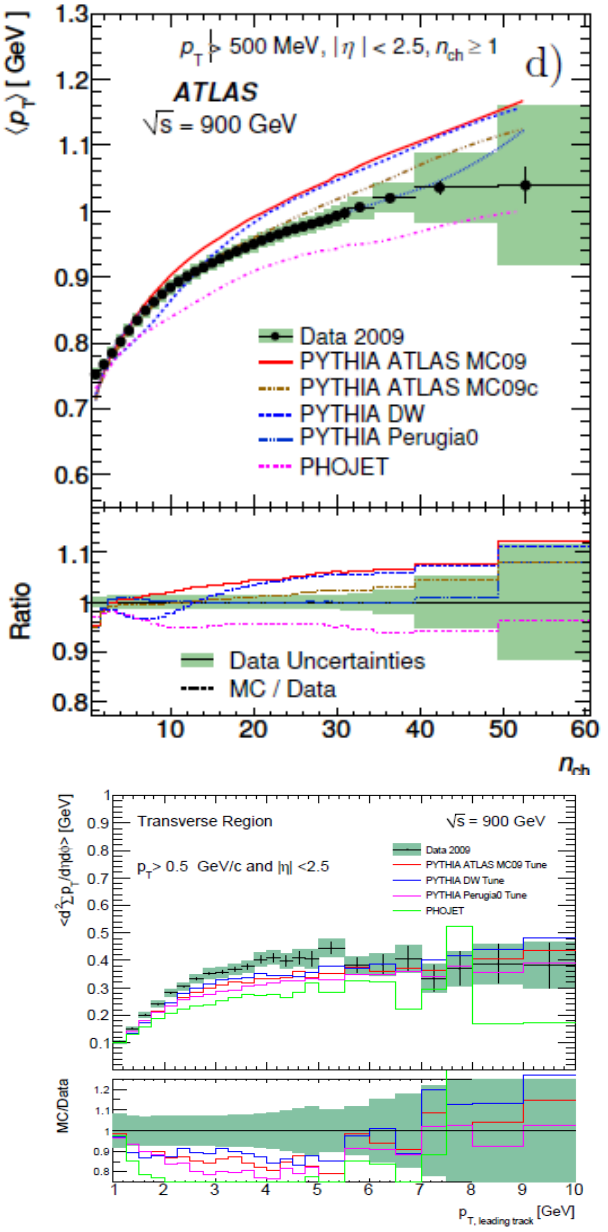

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Summary

- **Studies based on TopoClusters confirm the conclusions for charged-particle UE studies.**
  - MC tunes have smaller particle activity in the transverse regions
  - Monte Carlo tunes disagree with data
    - the largest problem with Perujia0 and DW tunes
- **Provide an independent check of track-based measurements**
- **Not every distribution done using tracks can be repeated using TopoClusters due to resolution and overlap effects**
- **We will concentrate on the distributions which have small bin-by-bin corrections using calibrated TopoClusters**
  - <pT> vs N and <pT> as function δφ have detector correction ~1
- **Finish the draft note and move forward with 7 TeV data**
  - **Convert 7 TeV D3PD (or ESD, AOD) to ntuples suitable for analysis**
    - **Smaller size, fast turnover, faster systematics checks**